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SBIR PROGRESS REPORT 2
INNOVATIVE DIRECT DETECTION RANGE-DOPPLER LASER RADAR
(CDRL # 0001AB)

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During this Phase of our research program EOS completed the Laser Radar preliminary design effort discussed below. In addition we initiated the evaluation of new applications of the high efficiency Multi Beam Fizeau Interferometer (MBFI) for dual-use DOD and commerical applications. This commercialization study effort appears very promising and will be reported on in the next Progress Report.

EOS has sucessfully developed preliminary design concepts for a new laser radar architecture employing the high-efficiency MBFI for precision estimation of the state vector of the target. This MBFI application possesses the following unique advantages:

- Unambiguous detection of fast-moving targets in a cluttered background, based on their unique Doppler signatures.
- Direct Doppler measurements on each pulse which, when combined with knowledge of range and filtered angle-angle data, provide an estimate of the target state vector ($\dot{R}$ and $\dot{A}$).
- Potential for more rapid and improved accuracy of state-vector estimation from the combination of a compact (e.g., 10-m) illumination beam and Doppler data on each return.

The laser radar design concepts developed in Phase I have the following features:

— The need for only moderate-coherence-length laser illuminators (e.g., 150 MHz at λ=532 nm), and direct-detection receivers;
— Receiver optics can be simple *photon buckets*, i.e., diffraction-limited optics are not required:
— Sharing the aperture receiver with the passive sensor becomes an attractive option;
— Negligible degradation of range and Doppler signatures caused by atmospheric turbulence.

The application of this new *laser radar architecture* was evaluated for sensor platforms (both aircraft and satellite) applied to precision tracking of Theatre Missile Defense (TMD) targets (e.g., Scuds) during boost through ballistic phases of target flight. Precision tracking design requirements were specified, such that the measured target state vector would be sufficiently accurate to allow:

— Target launch point location determined to 600—2000 m accuracy (1σ) by backward prediction from detection at altitudes above cloud level (e.g., 30—40 sec after launch).
— Predict-ahead accuracies of 500—1500 m (1σ) over forward prediction times of 100—300 sec of ballistic flight.

The resulting component requirements for the laser radar are quite reasonable, as illustrated below:

TYPICAL LASER POWER & APERTURE REQUIREMENTS

PLATFORM, LASER WAVELENGTH:	AIRBORNE, λ=1.06 μm	SATELLITE, λ=0.53 μm
Photon Bucket Rcvr Aperture Diam (m)	0.5	2
Slant Range (km)	500	4000
Laser Pulse Energy (J/pulse)	0.1	4
Pulse Repetition Frequency (Hz)	30	30
Beam Diameter at Target (m)	15	15
(S/N) per Detector	9	9